

all esculthras sprayed in July 1979

all other surfaces in December 1979

repeat all other March 1980

Things to do:

Growth quadrats

altar near C

Take notes on 2 months ago spraying

Str. 13 near snake man:

Lecanora on slanting surface - not dead yet!

" *P. modernii* dead but not disintegrating

Pyxine (orange medulla, apo) = isored. about 20% fallen
all dead.

P. tinctorum - tips bleached. falls off at touch

Ph. soorediosa - very adhesive. apparently dead. crumbles

Send report to Mancini

mosses (*Repaticus*) dead but still adhering

Tratamientos

	Feb 75	Mar 76	July 76	Jan 77	[Aug 77]	Jan 78
* Stela K	B+C	B+C	C	B+C	B+C	B+C+T
Zoom B	B+C	B+C	C	B+C	B+C	B+C+T
Zoom P+att.	-	B+C	C	B+C	B+C	B+C+T
* Mon. H	-	B+C	C	B+C	B+C	B+C+T
Mon. 13	-	B+C	C	B+C	B+C	B+C+T
Mon 14	-	B+C	C	B+C	B+C	B+C+T
* Stel. I	-	B+C	C	B+C	B+C	B+C+T
* Stel A	-	-	B+C	B+C	B+C	B+C+T
Zoom G	-	-	B+C	B+C	B+C	B+C+T
* Stela C	-	-	-	B+C	B+C	B+C+T
* Stela D	-	-	-	B+C	B+C	B+C+T
Stela E	-	-	-	B+C	B+C	B+C+T
Stela F	-	-	-	B+C	B+C	B+C+T
* Stela J	-	-	-	B+C	B+C	B+C+T

B = Borax
C = Chlorox
T = H₂O₂

Copán

July 1975

Report 1

Reconnaissance trip, a few Kodachromes

July 1976

Report 2

(S) Altars C, M, N; stelae C, M, N.

wall at Stela I; mossy steps at Str. 11;

5 m of wall Str. 13.

complete B&W & color. + spraying

Jan. 1977

Report 3

(S) selected B&W & color + complete spraying

July 1977

(S) complete respraying

Jan. 1978

Report 4 Sept. 1978

[repeat selected B&W & color]

June 1979

Report 5 Feb. 1980

Mar. 1981

July (S) - escul
Dec. (S) - rest

Copán

trataado enero 1977

Altare Est. C

Pared de Est. I

Altar Est. N

Altar Est. M

~~Altar~~ Est. N.

Est. M.

3 steps on Escalinata

Ceremonial altar near Est. 11

altar in front of 11 (flush with ground)

Est 14 wall

Est 11 steps

Copán notes

Jan 1977

Jan. 1977 - alone, selected color & B&W

July 1976 - with Julie - semi-complete B&W & color

Mar. 1976 - with Julie - complete B&W & color
Quirri & Copan

July 1975 - alone, selected Kodachrome + Black & W
reconnaissance at copan

Feb 1975 - 1st sprays.

Apr. 1973 - alone, a few Kodachrome - no quadratimg

Quirigua--observations made in June 1979

Zoomorph B--White weathering in grooves (foto)

Zoomorph G--

N side left: Trentopohlia gone

Oscillatoria in surcos

Zoomorph O

Front: some alga recolonizing

Stela A

Lower quadrats:

S side: white crust persists *gone*

N, E, W, clean except lower right N yellowish

Mid quadrats

All lichens gone N & S sides

Upper quadrats:

Phyllopsora on left crumbles

Orange crusts weakened

gone!

virtually gone
Asil now down almost 1 m!

Stela D

OK

~~R~~, N, S sides: clean except for few crumbling remnants

W: clean except some alga at top

extended down now!!

Stela C

N side: Phyllopsora 90% gone *gone*

S, E sides: more or less clean

W side: black rain streak down middle; orange spots (6-7) dull, dead

Stela F

N side: white crust fainter, little phyllopsora left

S side: Dirinaria 90% gone; face yellowish + hat top

W side: white crust much attenuated

big streak of alga from top!!

Stela J

N side: white crust attenuated (foto); Phyllopsora nearly gone

E side: do.. yellow coloration unchanged

S side: endolithic lichen persists; trace Dirinaria left

W side: More or less clean now

Top: darkening as alga returns

gone gone
no change
still here unchanged (foto)
- big little osil coming in on ledge below chin
- much more now

Stela I

Lower: little white discoloration left

Mid: clean except 10% alga on W side

Upper: clean except some alga recolonizing

- tented up on W side bottom
more now - big spread down W side

Stela K

Lower:

N side: only fragments of Leptotrema left (foto) - very few left
rub off as dust

E side: very little Leptotrema left

S side: 95% clean (foto)

W side: green alga invading in left crack - much spread of
osil foto!

Upper:

N side: clean

E side: 1% Chiodecton left } much osil spread

S, W sides: more or less clean

Mon. 8

Lower: clean

Upper: some white shadows on S side, otherwise clean

Mon. 14: White weathering in surcos - extensive black grooving! (foto)
+ moss beginning in bigger grooves.

Mon 13: Green alga on nose gone; white weathering in drainage surcos

all black on top 4 sides! (foto)

Zoomorpho P

E side: top edge above (O) Oscillatoria returning - obvious over 25%
Green alga in front - little left. (foto)

W side: some dull green, few streaks Oscillatoria,
has increased!

Altar P: Dead Trentepohlia on N side, inconspicuous

fresh now!

my copy

Copán July 17-20 1976
Treatment for biological growths

1. Stela C and 2 altars.
2. wall (2 x 6 m) left of Stela I.
3. 1 x 7 m strip on SW end Ball Court.
4. altar & Stela M
5. altar & Stela N
6. wall on NE corner Structure 11 (moss covered)
7. wall on NE corner structure 13 (lichen covered)

Spray all with 5:1 Chloro except NE quad (side)
of altar C (W altar) and Altar M.

Spray all with 5% borax except NE quad
of altar C (west altar) and Altar M.

invitation in 1973 by U. Penn. - beginning renovation project.
didn't believe - they paid. - happy to go as biologist!!
went to Guat. - result many lichens - submitted grant to N.G.S.

Looked at English work. - Briefly define lichen.

Black on buildings organic, as well as particulate
air borne microflora

methods: use spray to kill organisms.

various sprays: fungicides, copper sulphate
chlorox, borates, organo-tin compounds, phenolics.
effect basically is to kill algae

Started program 1975 ~~from~~ Guinju & Copan!!
training locals, have shifted to locals.

Brief history

Mayan civilization began about 2000 yrs ago

200-900 AD the climax when religious centers were built.

rulers put up stelae - can read dates! other
things like altars, various temples, etc.

last date 910 AD when civilization vanished.

ruins covered quickly by forest and remained
untouched till 1850, ca 1000 years. Stephens
visited - chopped way thru! & drew statues.

(over)

1896-1900 Harvard uncovered, cast molds
did some reconstruction - pictures show
dense forest cover and monuments ± clean.

1930-35 Harvard + Carnegie did major reconstruction
at Copan & Quirigua. opening up area for
tourists. - stairway at Harvard.

opening encouraged lichen growths which have
covered many monuments, eroded rock by hyphal
penetration, retention of moisture, etc.

after 3 years my results. - applied lichenology.

goal: 1. kill all microflora - algae - mosses, lichens
whole 2. Do not mechanically treat surface
program 3. Prevent reinvasion of microflora
4. Stabilize stone surface.

great importance as source of tourist money!

& cultural asset. - what goes thru minds
slides: illustrate many comparisons, etc. of locals!

1st site:

Lowlands of Guatemala - Caribbean coast - hot
- controlled river??

2d site Copan - about 50 m as crow flies,

} was in contact!!
} very large center.

	% NO_2O	% Cl	% SnO_2^*	% B
#1 ^{stH} not yellow	0.02	.04	0.05	N.D.
2 ^{stH} yellow	0.06	.07	0.02	N.D.
3 ^{stI} not yell	0.03	.04	0.03	N.D.
4 ^{*I} reddish area	0.04	.06	< 0.01	N.D.

N.D. NOT DETECTED. LIMIT OF
DETECTION 0.2%; HOWEVER
PRESENCE OF YELLOW SODIUM
FLAME INTERFERED. PROBABLY
AT LEAST < 0.5%.

* SnO_2 VERY LOW, DEFINITELY < 0.05%

Treatment

Zoom BN

top East side - Borax one coat
11:15 410cc algae Monogram
front S side chlorax
11:30 dries in 30 min.

PM - no direct sun
top west side - chlorax one coat

front 2d coat chlorax

side^(blt) west side - one coat borax

respray top east very light borax

Borax 500 cc / m

chlorax 300 cc / m

wash east side down
 $\frac{1}{2}$ toward N

Treatment

Stela K

South side respray with chlorox
at 2 PM. Already turned
dull rusty red. 300 cc/m

spray N side one coat chlorox
2 PM 300 cc/m

spray west surf borax one coat.

respray east side lightly.
very red!

Zoom. B

spray front 1 coat chlorax
south side

spray top west one coat chlorax

(sprayed top east one coat Borax)

spray west side west Borax one coat

spray from 2d coat chlorax

Treatment

Stela K

E side

11 AM spray borax
ca 500 cc to soak
chickadee turns orange red
at once!

S side chlorax one coat

Bora 500 cc / m²

chlorax 300 cc / m²

PM.

N side - one coat ~~bora~~ chlorax

S side - 2d coat chlorax

W side - no coat borax

E side light 2d coat borax

little sun. still moist

at 4:00

all the turns red.

1-6 Zoom BN Owl top west

7-20 Stela ~~10~~ K

Chiriquá

Stela K

East side
(Back)

Borax at 11 AM

2 d lite coat Borax 3 PM

[Turns red at once. Still moist at 4:00.]

(wash down at 5:00 $\frac{1}{2}$ toward N)

South side

Chlorax at 11 AM

2 d coat at 3:00 PM

[turned rusty red]

West side
(Front)

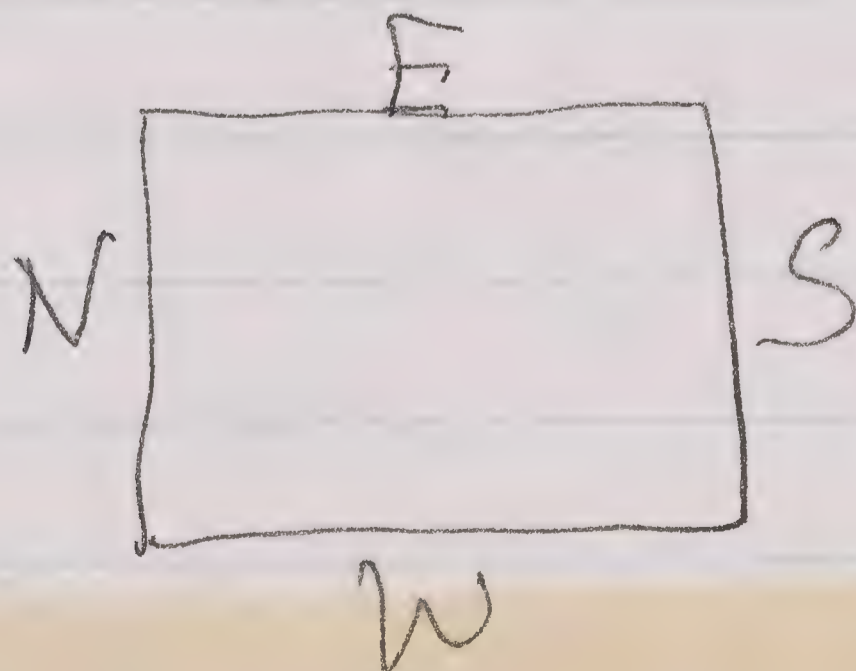
Borax at 3 PM

North side

Chlorax at 3 PM

Borax — 500 cc/m²

Chlorax — 300 cc/m²
woods



12 m²
120

Zoomorph B

Top - east side

Borax spray at 11 AM
respray 2 PM - lightly
[alga - turns green - dries in 30 min]

Top - west side

Chlorax at 2 PM
[no direct sun]

Front - south side

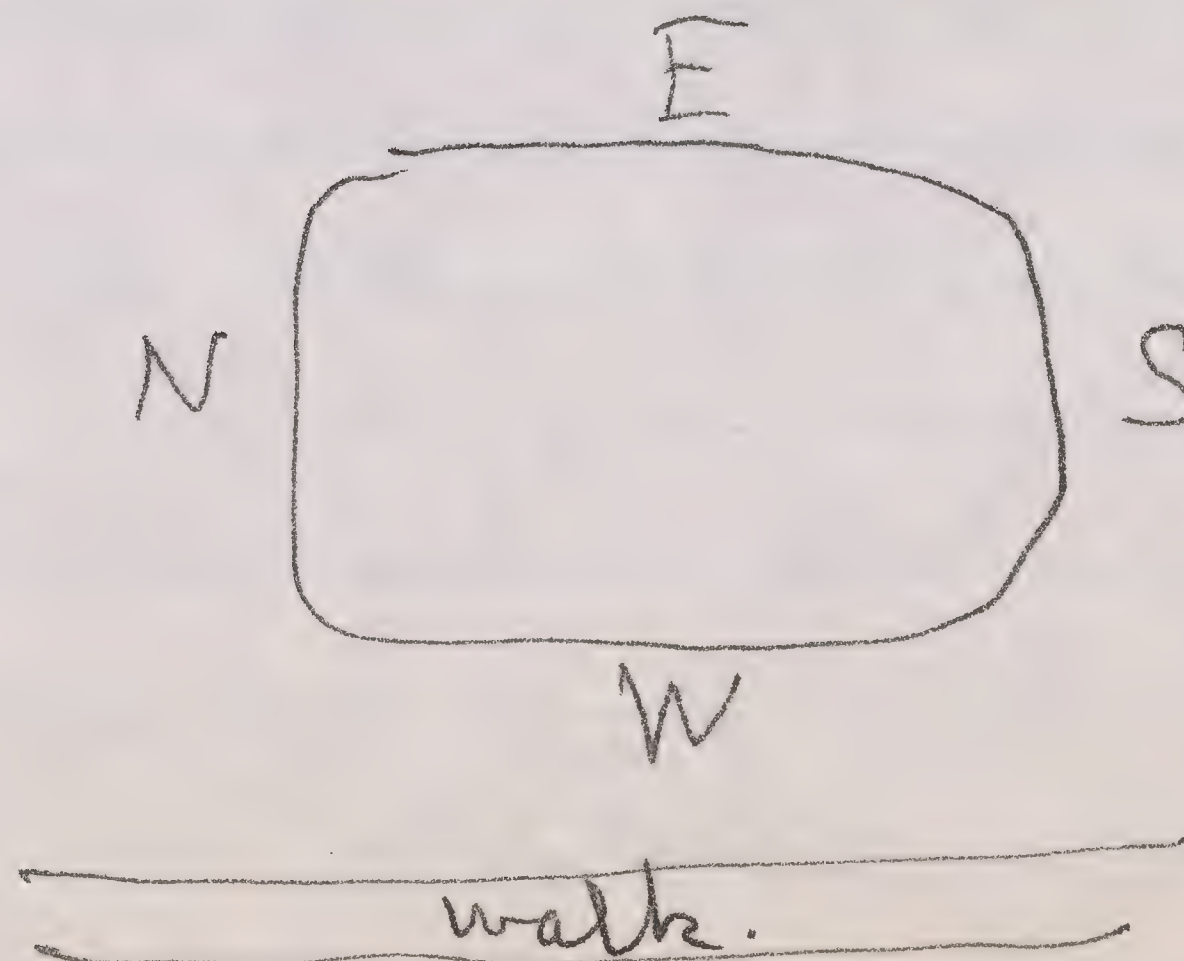
chlorax at 11:30
respray chlorax at PM

West side (vertical)

Borax in PM

Borax 500 cc/m²

Chlorax 300 cc/m²



Stela K

Frullania aureae

Mastigolejunea auriculata

Chiodecton antillarum

Leptotrema santense

Parmelia endosulfurea

Stela I

Parmelia endosulfurea

Dirinaria picta

Altar N

Leptotrema glaucescens

Dirinaria picta

Coccocarpia cronia

Bl & White fotos

July 1975

March 76

July 76

Jan 78 (big sens)

Sept. 78

June 79 - no black & white!

Roll 4 - Bl + White

Total Feb 1980

Temple Q - South wall

Stela 22 - S side

Stela 22 - N side

East wall - Q - coarse alga + smooth alga #2

~~exp~~ explication 22 Stela N. side

Stela - foot Temple Q P 69

Between Q + R Original mass cover
Complex R - Stela - S. side

~~N side~~ sharp

Flat carved outcrop below H

Complex P - Stela 20 S side

Complex N - Stela 16 -

Explication Stela 16

last Stela exp from
Cycl. N. change

Stela 24 - loose

Temple III
could be cleaned

Copan

Wall Str. 13

Sprayed Jul '76

Jan. 1977

6 months

^{endo,}
Parmo. tinct, cristifera 50-80% fallen off
Sticta, hepts, Usnea all disappeared
Phy. sorediosa dead & flaking
Heterodermia casaretti flaking off
Parmo crinitum 20% gone
Papillaria nigrescens ± gone or dead

Jan 1978

18 months

Parmotrema gone except few skeletal remain (< 10% left)
Papillaria gone
Ph. sorediosa mostly gone or 60-80% gone
Heterodermia gone
Papillaria - few frag left.

Sept. 1978

Phy sored 90% gone
crusts ± attenuated (to gone)

Altar Stela 4B

Sprayed July '76

~~Lin. per~~

Jan. 1977

[6 months]

Dirin picta } 20% gone
Ph. soed }

Parm. mordenii - 50% gone
mosses dead

Jan 1978

[18 months]

vert surfaces all clean

Phys soeds - few traces (20% ^{50%} ~~ad~~) on sides.
mosses gone

Sept. 1978

[27 months]

Clean except 20% or less Ph. soed. persists.

Altar C

Sprayed July 1976

Jan: 1977

6 months

Vivianaria confluens - dead but not much flaking

D. picta - dead

Parmot. mordenii - mostly gone!

Lecanora cinerea - persistent

Alga attenuated

Xanthoparmelia subrang. - \pm disappeared

Jan. 1978

18 months

D. regalis to 50% gone \pm all disappeared - bare outlines left.

Parm. all gone!

D. m.

alga. gone

Sept 1978

27 months

all clean.

- control quad after 9 months

100% gone, crumbling, all dead.

Wall Stela I

Sprayed July 1976

Jan. 1977

[6 months]

Phys. soiled. - 50% flaking & falling, 20-30% gone
Parmotrema mord. 75% vanished.
Can. Con - gone

Jan 1978

[18 months]

Parmotrema all gone

Phaeodermis - \pm gone on horiz surfaces.

5% or more left on vertical surfaces

Sept 1978

[27 months]

Ph soiled. on vert. surf. ~~to~~ 5% left - crumbling.

~~Stela A~~
Quirigua

Results Observed September 1978

Stela A

Lower quadrats:

N, E, and W sides: clean (originally no lichen cover)

S side: Dirinaria gone, Leptotrema now mostly gone, white crust shadow left; background algal cover much attenuated.

Mid quadrats:

E, W sides: already clean

N side: Phyllopsora 50% or more gone, crumbles easily.

S side: Most Phyllopsora gone; remnants of algae left.

Upper quadrats:

N side: Phyllopsora virtually all gone

E side: Alga and Phyllopsora mostly gone now; orange crust persists

S side: Alga 80% gone; Dirinaria already gone; Lepraria 10% left

W side: clean

Zorm P

E side mid just at top edge above (6)

Oscill ca 1' coming in

Green alga in front

Some dull green w side mid
+ few streaks oscill

June 79
dried out
& flaking

Room

spring algae

at top

stela C

stela A

Monument 13

Traces of green alga in gooves. Lichens in NE quadrant persistent.

Stela C

N side: Phyllopsora now 50% gone

E side: Little alga left; orange lichen persists.

S side: Phyllopsora all gone; alga 90% gone

W side: Phyllopsora all gone; moss at top 60% gone; orange spots turning yellowish

Stela D

N side: Phyllopsora about 50% gone now; crusts in lower half visible.

E side: latexed

S side: Phyllopsora 50% gone; Dirinaria mostly gone below face.

W side: Phyllopsora all gone; alga only at top now.

June: → mostly gone
white remains on R side! crumbles off
N & S all clean except
in microscopic crumbly spots

Stela F

N side: White crust on right edge faint; some Phyllopsora persisting lower rt; alga 80% gone.

E side (tilting): clean

S side: Hepatic now gone; Dirinaria about 70% gone; much remnant 10 ft up center.

W side: Phyllopsora 90% gone; alga also about 90% gone; Chiodecton and white crust at bottom about 50% gone.

Stela J

N side: Continued attenuation of white crust; few remnants Phyllopsora.

E side: White crust shadows on rt side to top; Dirinaria gone; yellow discoloration as in fotos + yellow mid right

S side: endolithic lichen conspicuous;; Dirinaria almost gone.

W side: Phyllopsora below face 50% gone; Dirinaria and white crust gone; lower 1 m was clean.

Top very clean, with conspicuous yellowing on oblique surface.

Darkening as alga returns!

Stela I

Lower quadrats:

N side: only white discoloration left. *OK*

E side: crusts mostly gone except right side. *mostly gone*

S side: already clean *OK*

W side: All clean as before; reddish color visible. *OK*

Mid quadrats:

N side: Phyllopsora all gone; alga 50% gone *all gone*

E side: 10 % alga left on either side of figure; red coloration center. *OK*

S side: 100% clean. *OK*

W side: Phyllopsora already gone; some alga left, rt. center. *some alga & regenerate*

Upper quadrats:

N side: All clean except remnant white patch upper left. *crumbly*

E. side: 30% alga left *OK little less*

S side: More or less all clean *lean*

W side: remnants of alga with whitish crust upper right; top clean

some alga regenerate *all clean*

Stela K

Lower quadrats:

N side: Leptotrema now 50% gone; all reast clean

E side: 10% Leptotrema left

S side: 90% clean now

W side: already clean now

continued - June - only frags left have foto
very little left! clean
95% clean! (have foto - June)
few rem. alga green on left crack

Upper quadrats:

N side: All clean except 10% Chiodecton left

E side: 80% Chiodecton gone

S side: Mosses gone now

W side: 90% white patches gone, rest clean

mon 13
green alga in upper
nose

June - can't see
now -
white "growth"
in drainage
lines

mon 14 - Gill in almost
all drainage cracks //
on top. !

June most drainage lines have
white "growth".

Altar P

Completely clean. Traces of yellow on E and S sides

" " but much Trentepohlia on N side - June 79 dead, not evident

Stela H

Lower quadrats:

N, W, E sides: clean except for white shadows on N side.

S side: white crust still evident

Upper quadrats:

N side: White crust flaking; Dirinaria gone now

E side: Remnant bases of Phyllopsora left; white crust 60% gone, flaking; alga more or less gone; yellow coloration highly visible.

W side: Chiodecton and Dirinaria more or less gone; reddish coloration.

S side: some white shadows left.

June - no change - have foto.
no sign of white "growth"

Altar O--clean

~~Altar~~

Zoomorph O

N side: Mosses gone; 20% alga left

E side: Alga reduced, less one sides

W side: White crust gone; mosses already gone; 20% alga left

Front: black alga on rt side persisting

Top: all clean.

some more
black
returning

Zoomorph G

N left: few remnants Leptotrema; Phyllopsora already gone; some alga on rt.

N right: mosses gone; little alga left.

W-1: mosses gone, alga mostly gone except on left

W-2, W-3: little alga left on sides.

E-1, E-2, E-3: little white crust left; Phyllopsora already gone.

Top: All quadrats clean now.

sky

not much more
in June

regeneration of Basill in drainage
pits?
much black streak on W slope

Trent: abundant on left N (gone in June)
(first sample)

Zoom B

June: abundant white
"growths" on drainage
patterns - all over.

= normal rock weathering? - brushes off and
is similar to a special
area of algae brushed
away

Star

~~Chaguan~~
Quirigua

mm 14

white weathering in grooves (surcos)

Stela K

Lower

N side: only frags of heptostrema (foto) -

E side: very little " left.

S side: 95% clean (foto)

W side: green alga in left crack

Upper

N side: clean now

E side: 1% chondrodont left

S, W: \pm clean.

alter P:

Dead Trentepohli on N side, inconspicuous

Mon. 8

Lower: clean

Upper: some white shadows on S side, otherwise \pm clean

Sept. 1978 → June 1979

Stela A

Lower quadrats:

S side: white crust persists

N, E, W clean except lower right N yellowish

Mid quadrats:

All lichens ± gone N & S sides

Upper quadrats:

Phyllopsora left crumbles

orange crusts weakened

Zoom P

E side: top edge above ② Oscillatoria returning

Green alga in front

W side: some dull green, few streaks Oscillatoria

Monument 13

Green alga on nose gone; white weathering in drainage grooves visible

Stela C

N side: Phyllopsora 90% gone

S, E side: ± clean

W side: black rain streak down middle

orange spots (6-7, 3-5 cm diam) dull, dead

Stela D

N, S sides: clean except for few crumbling remnants
W: clean except some alga at top.

Stela F

N side: white crust fainter; little *Phyllopsora* left.
S side: *Dicranaria* 90% gone; face yellowish + hat top.
W side: white crust much attenuated

Stela J:

N side: white crust attenuated (have foto); *Phyllopsora* nearly all gone.
E side: " " " ; yellow discoloration unchanged
S side: endolithic lichen still present; trace *Dicranaria* left.
W side: \pm clean now.
top: darkening as alga returns

Stela I

Lower: little white discoloration left.
Mid: clean now except 10% alga W side
Upper: \pm clean except alga recolonizing?

after 0: clean

Zoomorph 0

Front: some alga recolonizing

Zoomorph G

N side left: Trentepohlia gone

Ocellularia in surcos.

Zoomorph B

white weathering in surcos

Copan

Sept. 1978 - June 1979

Stela C

Altar C

Altar C (block)

Wall Stela I

Stela M

N side: some *Ph. soredivora* left.

W side: *Caloplaca* color faded

E & S - clean

Base W end - 10% left.

N extreme right "

Altar Stela M

E side rt.: weak background *Oscillatoria*; crusts crumbling.

" " left: clean

W sides: Tops clean; 5% *Ph. sored* left. crusts barely visible.

Stela N

white "pyrenes" persists

Altar N

Crustose forms gone on top, dead & crumbling on sides.

some green alga coming in around edge.

Ball court:

Few traces of alga 2 m up on left.

Stairway, NE corner Struct. 11

much green alga returning

Escalinata

Physcia sorediosa 90% gone, crumbs left

crusts ± remnant on vertical

with lens about 5% alga left.

horizontal surfaces clean!

Flush altar, Rt. 13

Few crusts upper left.

otherwise clean

Altar near stn 11

Physcia gone, crusts falling away.

Stela D

sprayed Jan 1977

Jan. 1978 - [12 months]

Phyllopsora dead, not falling yet. to 30% fallen
Drimaria flaking
Alga ~~only~~ all top left attempted

Sept. 1978 - [21 months]

Phyllopsora gone to 50% gone
Drimaria gone
only alga at top remaining

Stela C

Sprayed Jan. 1977

Jan 1978 -

[12 months]

Phyllopora white, \pm crumbling, persistent to 50% gone
alga 50% gone

Sept. 1978 -

[21 months]

Phyllopora 50% gone to nearly gone
alga much attenuated to gone

Stela I

march 1976 - sprayed.

July 1976 - [5 months]

Phyllopsora dead }
Dirinaria } barely beginning to flake
Parmotrema endo }
white crust beginning to alternate

Jan 1977 - [11 months]

Phyllopsora decaying & ± flaking
Dirinaria flaking
Parmotrema gone
alga 50% alternated
mosses mostly gone

Jan 1978 - [23 months]

white crust ± gone
hepatics gone
Phyllopsora ± all gone
Dirinaria ± gone, few remnants
alga + crusts 90% gone

Sept. 1978 [31 months]

white crust discoloration only
Phyllopsora all gone!
alga nearly all gone

Stela H

sprayed march 1976

July 1976 - [5 months]

Dirimaria } dead
Chordodon }
Parmot sulph)
white crust unchanged
Phyllopora dead
hepatic dead

Jan. 1977 - [11 months]

white crust attenuated
Dirimaria flaking
Phyllopora crumbling
Chordodon dead
alga attenuated

Jan 1978 - [23 months]

Dirimaria gone or flaking
Phyllopora crumbling
alga & W.C. attenuated

Sept. 1978 - [31 months]

white discolor persists
Dirimaria & chord gone
Phyllopora - very few remnants left.
crusts & alga 60% gone